BREATHING & EATING

Understanding Neonatal Respiratory Comorbidity and Supporting Smooth Transitions to PO Feeding

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FINANCIAL DISCLOSURES

ANJANETTE LEE, MS, CCC/SLP, CNT, NTMTC

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LEARNING OBJECTIVES

- Relate at least one way respiratory comorbidity might impact the acquisition of oral feeding and the attainment of typical feeding milestones in preterm and full-term infants.
- Determine at least two appropriate strategies to improve short term and long term feeding outcomes for preterm infants affected by respiratory comorbidity.
- Differentiate one habilitative intervention to support feeding outcomes that can be initiated on an infant's first day of life.

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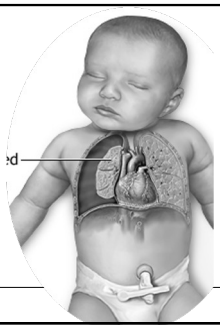
DESIGN & DEVELOPMENT OF THE RESPIRATORY SYSTEM



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ANATOMY & PHYSIOLOGY
THE LOAD

- Respiratory Tract – The Load
  - Upper Respiratory Tract
    - Nasal Cavity
    - Nasal Pharynx
    - Oral Pharynx
  - Lower Respiratory Tract
    - Larynx
    - Trachea
    - Bronchi
    - Lungs

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ANATOMY & PHYSIOLOGY
THE PUMP

- Musculoskeletal Support – The Pump
  - Diaphragm
  - Rib Cage
    - Intercostals
  - Accessory Muscles
    - Sternocleidomastoids (SCM)
    - Scalenes
    - Trapezius
    - Spinatus

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RESPIRATORY SYSTEM MUSCULOSKELETAL DEVELOPMENT

- The Pump
  - Grows and develops in the NICU
  - Musculoskeletal development is critical to lung function
    - Markedly affected by NICU environment
    - Rib cage growth/formation
    - Diaphragmatic and accessory muscle use pattern entrainment
  - Keep the development end goal in mind to support functional development of these components

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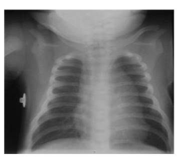
RIB CAGE DEVELOPMENT

- Shape
  - Neonate – perpendicular to sternum



https://www.researchgate.net/profile/Annemari_Groenewald/publication/328577608/figure/fig1/AS:687003540668416@1540805816228/Normal-neonatal-chest-AP-xray-10.ppm

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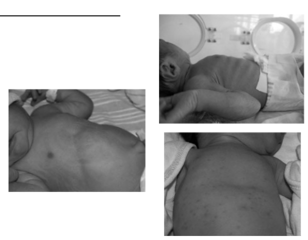
RIB CAGE DEVELOPMENT

- Composition
  - More cartilaginous
    - More compliant (collapsible)
- Impact on Breathing Strategy
  - Prevent lung collapse
    - Higher RR
    - Laryngeal adduction during exhalation
    - Maintenance of diaphragmatic muscle tone during expiration



https://med.stanford.edu/newborns/professional-education/photo-gallery/lungs-chest/_jcr_content/main/panel_builder/panel_0/panel_builder/panel_0/tabs/tab_main_panel_builder_panel_0_panel_builder_panel_0_tabs_11/image.img.full.high.jpg

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ACCESSORY MUSCLES DEVELOPMENT

- Not Able to Assist at Birth
  - Poor Length-Tension Relationship
- 3-6 Months Post-Term
  - UE Agonistic/Antagonistic Relationship Develops
  - ↑ Extensor Tone
  - Chest Wall Opens Up
  - Anterior Chest Muscles Assist w/Ventilation
- 6-12 Months Post-Term
  - Predominant Upright Posture
  - Gravity & Abdominal Muscles Pull/Rotate Ribs ↓
  - Intercostals Develop

Massery, 1991

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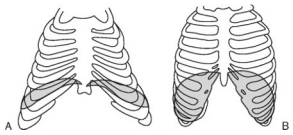
DIAPHRAGM DEVELOPMENT

- Functions
  - Inspiration
  - Swallowing & Emesis
  - Barrier
- Two Components
  - Costal Diaphragm
  - Crural Diaphragm
- Position
  - Neonate vs Adult
    - Horizontal neonatal ribs = less area of apposition = mechanical disadvantage



Greenspan, et al, 2005

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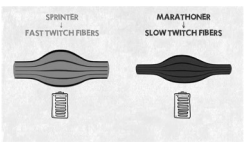
DIAPHRAGM DEVELOPMENT

- Composition Makes Susceptible to Fatigue
  - Muscle Fiber Impact
    - Type 1 – Red - Endurance Fibers
    - Type 2 – White - Speed Fibers
  - Only 10% is Type 1 Muscle in Preterms
  - 25% is Type 1 by Term



Greenspan, et al, 2005

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RESPIRATORY DISTRESS

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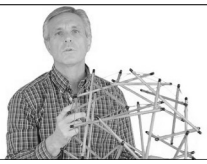
BIOTENSEGRITY

"Once in full gravity, immediately after birth, the NICU infant carries with them a Biotensegrity, a load throughout its entire body and its systems that will affect all systems > molecular level to the global, synactive functions."

John Chappel, MA, RPT



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RESPIRATORY DEVELOPMENTAL COMMONALITIES

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RESPIRATORY DEVELOPMENTAL COMMONALITIES

- Neonatal Respiratory Diagnosis
  - Meconium Aspiration Syndrome (MAS)
  - Respiratory Distress Syndrome (RDS)
  - Persistent Pulmonary Hypertension (PPHN)
  - Respiratory Insufficiency
  - Chronic Lung Disease (CLD) – Bronchopulmonary Dysplasia (BPD)
  - Pneumothorax
  - Pleural Effusion
  - Pneumonia

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RESPIRATORY DEVELOPMENTAL COMMONALITIES

- Developmental Impact of Respiratory Comorbidities
  - Oral-Motor and Sensory Impact
    - Excessive oral stimulation – OGT/ETT insertion and maintenance, CPAP interfaces, secretion production and hygiene
  - Nutritional Impact
    - Increased WOB = Caloric Consumption = Slow Wt Gain
    - Delayed PO initiation
    - Lack of endurance for aerobic activity of eating
    - Difficulty with S/S/B triad
  - Sleep Disturbances
    - Who is assessing for this?
    - Lack of REM sleep negatively impacts brain growth
    - Lack of Quiet sleep negatively impacts physical growth

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RESPIRATORY DEVELOPMENTAL COMMONALITIES

- Developmental Impact (cont'd)
  - Musculoskeletal
    - Static Positioning
    - Limited independent movement
    - Maladaptive Breathing Patterns
      - Scapular Breathing
        - ↑ Upward Mobility of Ribcage for ↑ Tidal Vol & Forced Residual Capacity
      - Neck Hyperextension
        - ↑ Anterior Chest Wall Expansion
  - Nurturance/Family
    - Limited &/or Altered Parenting/Bonding

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HABILITATIVE STRATEGIES

Pre-Feeding

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HABILITATIVE STRATEGIES

- Mobilization & Movement Facilitation
  - Benefits
    - May ↓ Sedation Needs
    - May Shorten Time on Vent
    - Edema Management
    - Secretion Mobilization
    - May Assist RR Regulation
  - Strategies
    - Skin-to-skin Holding – early and often
    - During Caregiving
      - Gentle semi-upright hand containment/holding
      - Supported active or passive movement opportunities

Ortmann & Dey, 2019 Zimmerman & Barlow, 2012

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HABILITATIVE STRATEGIES

- Positioning Management
  - NT Roles
    - Monitoring
      - In between caregiving periods
      - During caregiving
      - During procedures
    - Education to support 24/7 consistency
      - Professional caregivers
      - Family caregivers
    - Assistance at bedside during caregiving & procedures
      - Assess infant needs
      - Attain/maintain optimal positioning

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POSITIONING CONSIDERATIONS

- Diaphragm is Anchored Circumferentially
- Diaphragm Receives Pressure from Above & Below
- Structures Pass Through It
  - Aortic Hiatus
    - Aorta
    - Azygos Vein
    - Thoracic Duct
  - Esophageal Hiatus
    - Esophagus
    - Vagus Nerve
  - Caval Hiatus
    - Inferior Vena Cava

https://www.purposegames.com/images/games/background/232/232512.png

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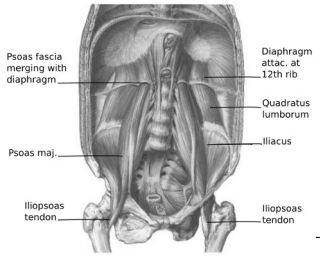
HIP FLEXION & BREATHING

Position of the muscles below the diaphragm can affect the diaphragm and structures running through it.



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HABILITATIVE STRATEGIES

- Positioning Strategies
  - Prone – Most Supportive for Breathing
    - Optimal Length-Tension Ratio for Diaphragm
      - Must have knees tucked & hips flexed
    - Allows Gravity to Assist Diaphragm
    - Allows Posterior Chest Wall Excursion
      - Must have shoulders adducted and arms flexed and dropped down
    - Support Surface Provides Chest Stability via Weight Bearing
      - Must have elevated proning support in place
    - Keep head turned ≤ 45 from midline
      - Decrease Dolichocephaly/Scaphocephaly
      - Maintain Optimal Airway

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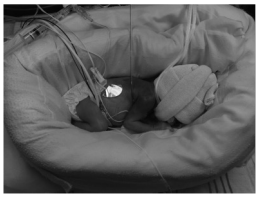
HABILITATIVE STRATEGIES

- Positioning Strategies (cont'd)
  - Sidelying
    - Alternating R & L Important
      - Symmetrical Rib Cage Development
      - Atelectasis Prevention
      - Edema Prevention
    - Bedding Support Against Spine
      - Stabilization of Spinal Rib Insertions
    - Head in Neutral Flexion
    - Hips Flexed with Knees Tucked to Tummy
      - Gives Optimal Length-Tension Ratio for Diaphragm



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HABILITATIVE STRATEGIES

- Positioning Strategies (cont'd)
  - Supine – Least Supportive for Breathing
    - Gravitational Impact Greatest in Supine
    - Close Attention to Flexion Maintenance
      - Full Contact Support of Bedding
        - Under Triceps to Keep Hands Up and Accessible for Grasping & Calming
        - Against Bottom to Keep Hips and Knees in Flexion
    - No Shoulder Rolls!
      - Pressure on Occiput
      - Promote Neck Hyperextension

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HABILITATIVE STRATEGIES

- Stress Relief
  - Skin-To-Skin Facilitation
    - Parents underestimate impact
    - Schedule STS session with parents
    - Added feeding benefits for infant and mother
  - Massage
    - Assists in Decreasing
      - Scapular Breathing Pattern
      - Neck Hyperextension
    - Neonatal Touch and Massage Certification Program
    - Certified Infant Massage Instructor Program

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HABILITATIVE STRATEGIES

- Oral Aversion Prevention
  - Hands to Face/Mouth Facilitation
  - Positive Facial Touch
  - EBM/Formula Tastes
  - Equipment Review
    - Type of ETT interface
    - Type of tape
    - Type of suction catheter
    - Type of CPAP interface
  - Procedural Review
    - Suctioning
      - Frequency
      - Method
    - Taping
      - Frequency
      - Method

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HABILITATIVE STRATEGIES

Oral Feeding

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HABILITATIVE STRATEGIES

- Oral Feeding Initiation with Respiratory Support
  - CPAP?
    - Aspiration Risk Research
      - Canning, et al, 2021 – Systematic Review
        - Insufficient evidence to conclude safety
      - Ferrara, et al, 2017 – VFSS Analysis
        - CPAP +5, 21-37% FiO2, RAM cannula
        - Bolus airway invasion with 1st 7 patients on CPAP
        - No bolus airway invasion when switched to 1 LPM NC

Canning, et al, 2021 Ferrara, et al, 2017

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HABILITATIVE STRATEGIES

- Oral Feeding Initiation with Respiratory Support (cont'd)
  - CPAP? (cont'd)
    - Aspiration Risk Considerations
      - PMA & Size of the Infant
        - PEEP generated is handled differently with musculoskeletal maturity
      - Previous PO Experience
        - New to PO or some previous experience?
      - Type of Nasal Interface
        - How much leaking at the nares? >leak = easier flow diversion during swallowing
      - Type of CPAP
        - Variable Flow/Infant Flow/Fluidic Flip = easier to exhale against

Dalgleish, et al, 2016

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HABILITATIVE STRATEGIES

- Oral Feeding Initiation Tools
  - Risk Assessment for Oral Feeding on HFNC
    - Risk-adjusted score based on
      - PMA
      - Previous experience with PO feeding
      - O2 flow rate
      - FiO2 requirement as an indication of infant fragility/risk
      - Comorbidities/Medical Complexity
    - Suggests degree of oral feeding appropriate

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Risk Assessment for Oral Feeding on High Flow Nasal Cannula

For Infants Up to 12 Mos. of Age

(Adapted from Robin P. Glass & Lynn S. Wolf)

	2	1	0
Full oral feeding prior to HFNC	None	< 3 weeks	≥ 3 weeks
Medical Complexity	Very Complex	Moderately Complex	One System Only
Airway Protection/Aspiration Risk	Extremely Fragile – High FiO2	Stable with Significant Support – Moderate FiO2	Weaning Respiratory Support Regularly – Room Air
O2 Flow Rate (based on corrected age)	< 37 weeks: ≥ 4 LPM ≥ 37 weeks: ≥ 5 LPM ≥ 2 mos Corrected: ≥ 6 LPM	< 37 weeks: 2.5 – 3.5 LPM ≥ 37 weeks: 3.5 – 4.5 LPM ≥ 2 mos Corrected: 4.5 – 5.5 LPM	< 37 weeks: ≤ 2 LPM ≥ 37 weeks: ≤ 3 LPM ≥ 2 mos Corrected: ≤ LPM

Scoring Ranges from 0 to 10 — Baby must also meet the general criteria for feeding at that level – GA, RR, and Feeding Readiness Cues

Score 0-2: Low Risk – Consider oral feeding
Score 3-4: Greater Risk – Needs discussion & may be candidate for limited oral feeding activity
Score ≥ 5: High Risk – Not a good candidate for oral feeding

Continuum of Oral Feeding

Non-Nutritive/ Oral Sensory Activity — Tastes — Pacifier Dips — Nipple – Slow Flow — Nipple – Standard Flow

Score 5-10 | Score 3-4 | Score 0-2

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HABILITATIVE STRATEGIES

- Oral Feeding Initiation Tools
  - Eating In SINC Program
    - Algorithm Format
      - Qualifying Infants = born at <33 wks, physiologically stable, HFNC or w/o NCPAP, can swallow/manage secretions, showing hunger cues
      - Safety based and cue based
      - Begins with NNS at pumped breast or on pacifier
      - Restricts, then slowly advances volumes and time spent eating

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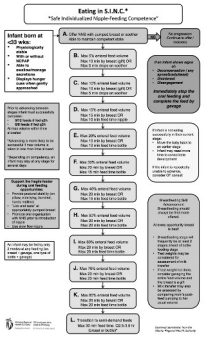

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HABILITATIVE STRATEGIES

- Considerations for Initiation and Advancement of Oral Feeding for Infants on Increased Respiratory Support
  - Limited Research on Oral Feeding w/HFNC or CPAP
  - Anatomy and physiology of aerodigestive tract
  - Current evidence base
  - Each infant's competence, sensitivities, risk
  - NICU team's knowledge and comfort with feeding

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TEAM TINY HUMANS

"Coming together is the beginning. Keeping together is progress. Working together … is success."

Henry Ford

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